

IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations

Sponsor
**Nuclear Power Engineering Committee
of the
IEEE Power Engineering Society**

Approved December 5, 1991
IEEE Standards Board

Abstract: Class 1E portions of ac and dc power systems and instrumentation and control power systems in single-unit and multiunit nuclear power generating stations are covered. Not included are the preferred power supply; unit generator(s) and their buses; generator breaker; step-up, auxiliary, and start-up transformers; connections to the station switchyard; switchyard; transmission lines; and the transmission network. The intent is to provide criteria for the determination of Class 1E power system design features, criteria for sharing Class 1E power systems in multiunit stations, and the requirements for their testing and surveillance.

Keywords: Class 1E power systems, nuclear safety, nuclear power station design

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

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Printed in the United States of America

ISBN 1-55937-191-9

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Secretary, IEEE Standards Board
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Foreword

This foreword is not a part of IEEE Std 308-1991, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.)

This standard presents criteria and requirements for the electrical power systems of nuclear power generating stations specifically related to providing protection for the health and safety of the public. The Institute of Electrical and Electronics Engineers has developed these criteria to provide guidance in the determination of the design features and the surveillance requirements and testing related to the station electric power systems. Each applicant for a construction permit or an operating license for a nuclear power generating station in the United States is required to develop these items to comply with the Title 10, Code of Federal Regulations, Part 50. Adherence to these criteria may not suffice for assuring the public health and safety because it is the integrated performance of the structures, the fluid systems, the instrumentation and the electric systems of the station that limits the consequences of accidents. Failure to meet these requirements may be an indication of system inadequacy. Each applicant has the responsibility to assure himself and others that this integrated performance is adequate.

Background

The original edition of IEEE Std 308-1970 was prepared by Subcommittee 4, Auxiliary Power Systems of the Joint Committee on Nuclear Power Standards (JCNPS) of the IEEE Nuclear Science Group and the IEEE Power Engineering Society (PES). IEEE Std 308-1971 incorporated the experience of the first edition and added multiunit considerations. The second edition, IEEE Std 308-1974, was completed by Working Group 4.1 of Subcommittee 4.1 of JCNPS, which became the Nuclear Power Engineering Committee (NPEC) of the PES in 1973. The third revision, IEEE Std 308-1978, clarified the interface between the functional requirements of the Class 1E power system and the safety systems for elements of the safety system that are within the Class 1E power system. The IEEE Std 308-1980 revision implemented the recommendations of the Ad Hoc IEEE 308/603 Committee regarding the scope diagram for the IEEE Std 308 and Std 603 interface.

Safety Function Concept

A safety system, by definition, must encompass all of the elements required to achieve a protective or safety function. Figures 2 and 3 illustrate the systems and equipment needed to perform a typical safety function, such as post-accident heat removal. As part of the safety system, the role of the Class 1E power system is clearly that of an auxiliary supporting feature, providing electric power to other safety systems; for example, recirculation spray system, containment spray system, etc. In this capacity, those portions of the Class 1E power system that contribute to performing a safety function must comply with the requirements of IEEE Std 603-1991. However, those components, equipment, and systems within the Class 1E power system that perform no direct safety function, such as overload devices, protective relaying, etc., must meet those requirements in IEEE Std 603-1991 that assure that those components, equipment, and systems do not degrade the Class 1E power system below an acceptable level.

Major Role of Class 1E Power System

The major role of the Class 1E power system is to provide electric power to the reactor trip system, engineered safety features, and auxiliary supporting features; and, therefore, the Class 1E power system is an auxiliary supporting feature.

The Class 1E power system is unique in that it extends throughout the plant, having far more complex interfaces than other auxiliary supporting features. Other auxiliary supporting features are usually limited to one area or a single process in the plant, and are basically mechanical systems. Characteristic of the complex interfaces of the Class 1E power system is the fact that it is an auxiliary supporting feature; other auxiliary features are auxiliary supporting features for it, and the Class 1E power system may provide support for nonsafety system equipment as well as providing the means for the execution of the safety system protective actions.

The sense and command features include equipment that produces signals (current transformer, voltage transformer, etc.), measures electric system parameters (voltage, current, watts, etc.), or functions to limit degradation effects (protective relaying, thermal overloads, undervoltage relays, etc.). Those sense and command features of the Class 1E power system that directly perform a safety function must comply with the requirements of IEEE Std 603-1991. Sense and command features of the Class 1E power system that do not have a direct safety function must be analyzed to show that their failure will have no unacceptable effects on the Class 1E power system.

In their execute features role, some Class 1E power system equipment, switchgear, circuit breakers, power cabling, and loads (primarily motors) are not only part of the Class 1E power system, but are integral parts of the engineered safety features as well.

Current Revision

IEEE Std 308-1991 is a general revision to the previous standard. The standard has been expanded to include the criteria for interfacing the Class 1E power system with IEEE Std 765-1983, IEEE Standard for the Preferred Power Supply for Nuclear Power Generating Stations, and with IEEE Std 741-1990, IEEE Standard Criteria for the Protection of Class 1E power systems and Equipment in Nuclear Power Generating Stations. The standard also has been updated to reflect the latest requirements of IEEE Std 387-1984, IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations; IEEE Std 946-1985, IEEE Recommended Practice for the Design of Safety-Related DC Auxiliary Power Systems for Nuclear Power Generating Stations; and the recommendations of the NPEC Ad Hoc Committee on Shared Safety Systems. These recommendations resulted in a complete rewrite of Section 8., Multiunit Station Considerations.

Working Group SC 4.1 members involved in the preparation of this standard were the following:

L. C. Gonzalez, Chair

L.A. Diaz
B. Grim
F. Gruscavage

G. Monasco
H. Robinson
M. J. Scruggs

K. S. Vavilala

The following persons were on the balloting committee that approved this document for submission to the IEEE Standards Board:

S. Aggarwal
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IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations

1. Scope

This standard applies to the Class 1E portions of the following systems and equipment in single unit and multiunit nuclear power generating stations:

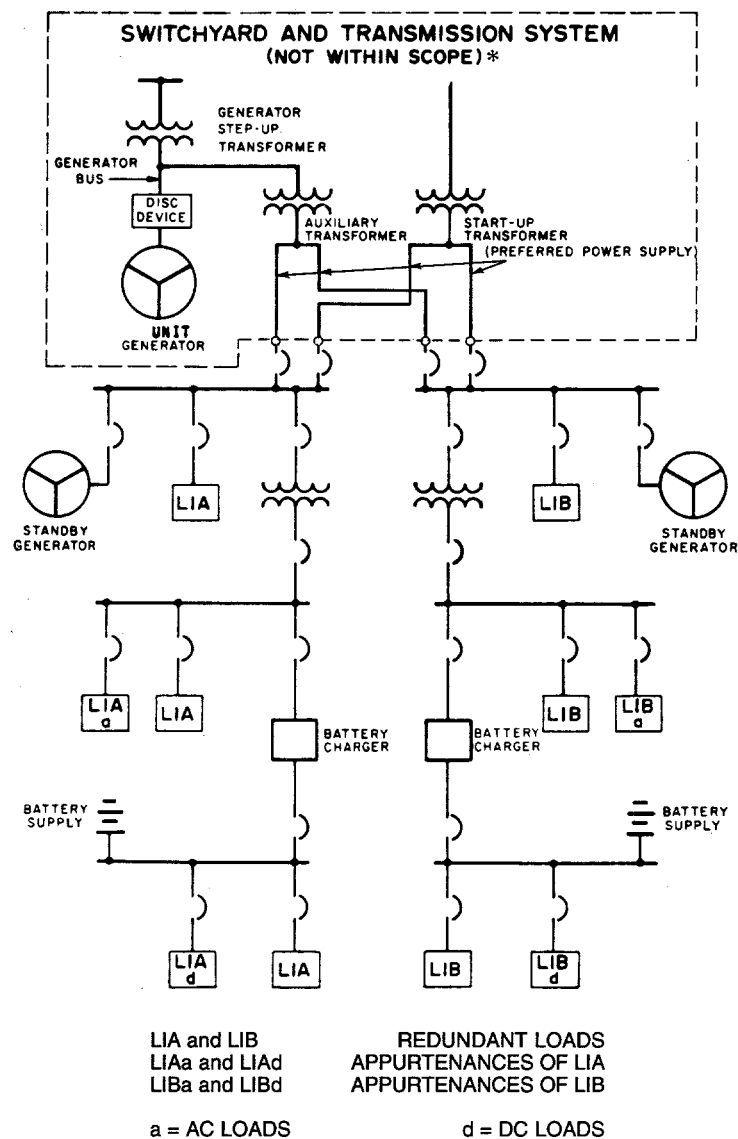
- 1) Alternating current power systems
- 2) Direct current power systems
- 3) Instrumentation and control power systems

These systems include those items listed in Table 1.

Table 1—Items Included in Systems Covered by Scope

General Elements	Illustrative Examples
<u>Power Sources</u>	
Sources	Standby generator Batteries
Components and distribution	Transformers Buses
Equipment	Switchgear Cable Battery chargers Inverters
<u>Execute Features</u>	
Actuation devices	Circuit breakers Controllers Control relays Control switches Pilot valves
Actuated equipment	Motors Solenoids Heaters
<u>Sense and Command Features</u>	
Instrumentation, controls, and electrical protection (associated with power supplies and distribution equipment)	Surveillance indicators Switches Current transformers Voltage transformers Transducers Protective relays Frequency relays Microprocessors

This standard does not apply to the preferred power supply; the unit generator(s) and their buses; generator breaker; step-up, auxiliary, and start-up transformers; connections to the station switchyard; switchyard; transmission lines; and the transmission network (see Fig 1).



Refer to IEEE Std 765-1983 [17] for recommended designs.

Figure 1—Example of an Acceptable Class 1E Power System for Single Unit With Two 100% Capacity Divisions

2. Purpose

The purpose of this standard is to provide the following:

- 1) The principal design criteria and the design features of the Class 1E power systems that enable the systems to meet their functional requirements under the conditions produced by the applicable design basis events.
- 2) The requirements for tests and surveillance of the Class 1E power systems.
- 3) The criteria for sharing Class 1E power systems in multiunit stations.